

Successful Removal of Two Osteomata
of the Orbit: One Originating in
the Frontal, the other in the
Ethmoidal Cells



WITH A HISTORY OF OSTEOMATA OF THE NEIGHBORING
PNEUMATIC CAVITIES OF THE ORBIT

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SUCCESSFUL REMOVAL OF TWO OSTEOMATA OF THE ORBIT: ONE ORIGINATING IN THE FRONTAL, THE OTHER IN THE ETH- MOIDAL CELLS.

WITH A HISTORY OF OSTEOMATA OF THE NEIGHBORING
PNEUMATIC CAVITIES OF THE ORBIT.¹

THE exostoses which intrude into the orbit from the neighboring cavities are very rare. In 290,579 cases of eye-disease observed at the New York Eye and Ear Infirmary since 1821, orbital exostosis occurred three times; at the Manhattan Eye and Ear Hospital, New York, two cases were observed in 73,804 cases of eye-disease; at the New York Ophthalmic and Aural Institute, it was observed three times in 65,608 cases of eye-disease; therefore, eight cases of orbital exostosis were observed in 429,989 cases of eye-disease. Many surgeons in large ophthalmic practice have never met with this disease. The number of cases of orbital exostosis recorded by foreign surgeons is small, and the results of operative treatment have been most discouraging.

I have collected all the cases of osteoma of the frontal, ethmoidal, and sphenoidal sinuses which have been recorded; and I have cited briefly those cases which have been carefully observed, because some of them furnish valuable information from a practical stand-point. They show us what we are to expect after the removal of the growths in question by a surgical operation, and some of the fatal cases suggest to us a way by which we may

¹ Read before the Section in Surgery, New York Academy of Medicine, May 9, 1887.

1847/35

possibly avert the disastrous issue. The records of these cases may be tiresome reading, yet they are the only thorough basis for arguments and rules.

Anatomy.—The *ethmoidal cells* contained in the “lateral masses” of the ethmoid bone consist of pneumatic spaces of variable size and number. They are divided into three sets—anterior, middle, and posterior cells—



FIG. 1.—View of the Three “Meatus” of the Nose. (Holden.) 1. Probe passed through frontal sinus into middle meatus; 2, nasal bone; 3, unciform process of ethmoid bone; 4, middle spongy bone; 5, superior meatus; 6, superior spongy bone; 7, sphenoidal sinus; 8, pterygo-palatine canal; 9, spheno-palatine foramen; 10, middle meatus; 11, inferior meatus; 12, nasal process of superior maxillary bone; 13, lachrymal bone; 14, orifice of antrum; 15, inferior spongy bone.

which intercommunicate. The cells on the upper surface of either “lateral mass” are roofed in by corresponding cells in the orbital plate of the frontal bone; those behind are closed by the body of the sphenoid and the orbital process of the palate-bone; those in front are walled in by the lachrymal bone; those below, by the superior maxillary bone. On the outer side of each

"lateral mass" the cells are closed by a smooth, thin, square plate of bone, called the "os planum" or lamina papyracea, which belongs entirely to the ethmoid, and forms a large share of the inner wall of the orbit. The ethmoidal labyrinth (or cells) sends a pneumatic process (called, by Zuckerkandl, bulla ethmoidalis) into the middle

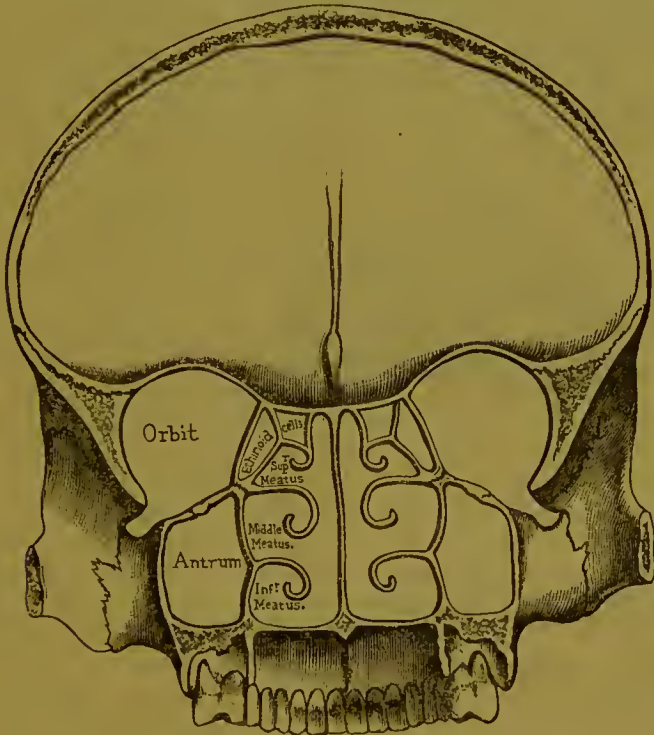


FIG. 2.—Section showing the Meatus of the Nose. (Holden.)

turbinated bone, which may attain the length of twenty-six millimetres, and is capable of displacing the septum of the nose laterally.

Two thin plates of bone stand out from the surface of the "lateral mass" which looks toward the septum of the nose, known as the "turbinated" or "spongy" bones of the ethmoid—*i.e.*, the "superior," "middle," and the

"inferior" spongy bone—not belonging to the ethmoid. The spaces left between these spongy bones and the "lateral masses" are called the superior and middle "meatus" of the nose. The superior meatus, being farther back than the middle one, leads into the "sphenoidal sinus," and also into the "posterior ethmoidal cells;" the middle meatus leading into the "anterior ethmoidal cells" (distinct from the posterior) and also to the frontal sinus, along a funnel-shaped canal (the "infundibulum") which passes through the foremost of the ethmoidal cells. The ethmoid has, therefore, an im-

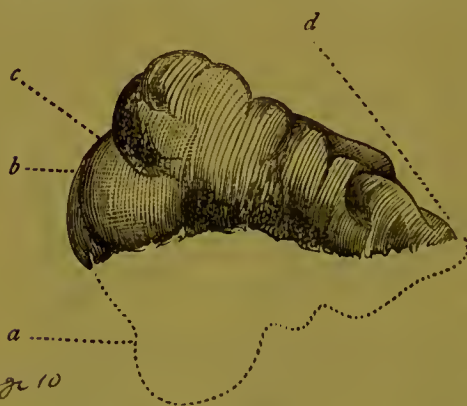


FIG. 3.—Side View of Fig. 4. *a*, Portion in nasal fossa; *b*, orbital portion; *c*, anterior portion; *d*, posterior portion.

portant relation to the nasal fossæ. It is likewise in intimate relation to the cranial cavity, as its "horizontal plate" forms a part of the bone of the skull. The ethmoidal cells sometimes send large prolongations into the frontal bone. One of the maxillary cells of Haller, which lie in the frontal process of the superior

maxilla and communicate with the ethmoidal cells, may have a very pronounced development, in which case the antrum of Highmore has been found to be divided into two *étages*, the upper one communicating with the ethmoidal cells (Zuckermandl). The lateral ethmoidal cells are not infrequently so greatly developed that they appear as prominences at the inner wall of the orbit. Dehiscences occur in the os planum, orbital wall of the frontal sinus, and the antrum of Highmore. In brachycephalæ the ethmoidal cells are likely to be greatly developed (Berger and Tyrmann).

As the greater number of the orbital osteomata are found in young people, and may have developed in the first year of life, it has been assumed that they had some relation to the development of the bones.

Development of the frontal and ethmoidal sinuses.—At birth there are no traces of the frontal sinuses. The foundation of the frontal sinuses is furnished by the cartilaginous ethmoidal cells. Dursy (*Entwickelungs Geschichte d. Kopfes*) states that the frontal sinuses develop from independent cartilaginous layers by liquefaction of the cartilage; while Steiner's (*Archiv f. klin. Chirurgie*, vol. xiii.) view is that their development is intimately connected with the cellular spaces of the anterior ethmoidal cells.

The foundation of the nose is derived from the medial, soft, later on, cartilaginous frontal process, and the two lateral processes of the superior maxilla. Two lateral curved processes start from the frontal process, from which, in turn, crooked protuberances

(the future "turbinated bones" of the nose) branch off; from this frontal process also start outward and upward processes, which are the foundation of the ethmoid cells and the ethmoidal plate, and finally form the rudiments of the antrum of Highmore below. The pneumatic spaces result from the liquefaction of the cartilage, into which the mucous membrane of the nasal cavity is invaginated. The liquefaction of the cartilage begins in the posterior



FIG. 4. — Section of Osteoma of the Ethmoid. Actual size. *a*, Sixteen mm.; *b*, portion which intruded into nasal fossa; *c*, orbital portion; *d*, compact bone; *e*, thirty-four mm.; *f*, cancellous bone.

ethmoidal cells and in the sphenoid, already, in the fifth month of foetal life. In the foetus of six months, small cartilaginous processes pass from the rudiment of the ethmoidal cells into the pars nasalis of the frontal bone, which later form the frontal sinuses. Ossification begins in the ethmoid bone in the fourth month after birth. The frontal sinuses are developed in the eleventh to thirteenth year. The development of the frontal sinuses begins with development of the pneumatic spaces of the anterior ethmoidal cells ; for the frontal sinuses represent only the expansion of the anterior ethmoidal cells from above (Steiner).

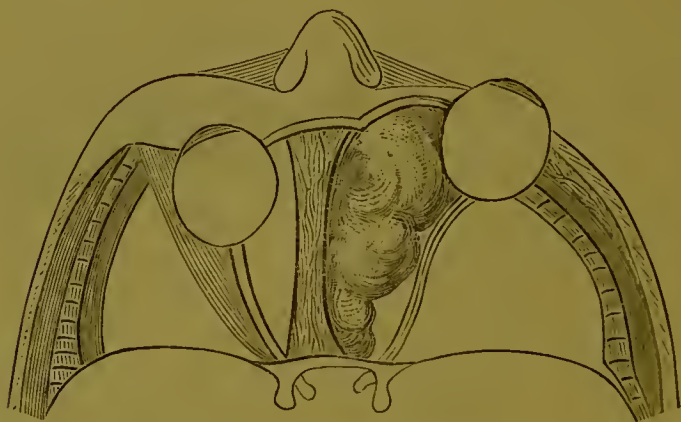


FIG. 5.—Showing Tumor in Orbit.

The sphenoidal sinuses are developed before the frontal sinuses, *i.e.*, second to third year of life (Steiner). In the adult they gradually become large enough to excavate the whole body of the bone, and in old skulls the sinus often extends into part of the basilar process of the occipital bone (Holden). The anterior wall of the sphenoidal body may be entirely wanting, in which case the sphenoidal sinus would open into the ethmoidal cells. Small dehiscences have been found in the lateral wall of the sphenoid, which lead into the middle cranial fossa

(Zuckerkindl). When this latter condition obtains, an inflammation in the sphenoidal sinus may readily be propagated to the dura mater.

Bornhaupt found the anterior portion of the frontal bone solid in the third year, without the slightest trace of frontal sinuses. The adult skull which I show you is

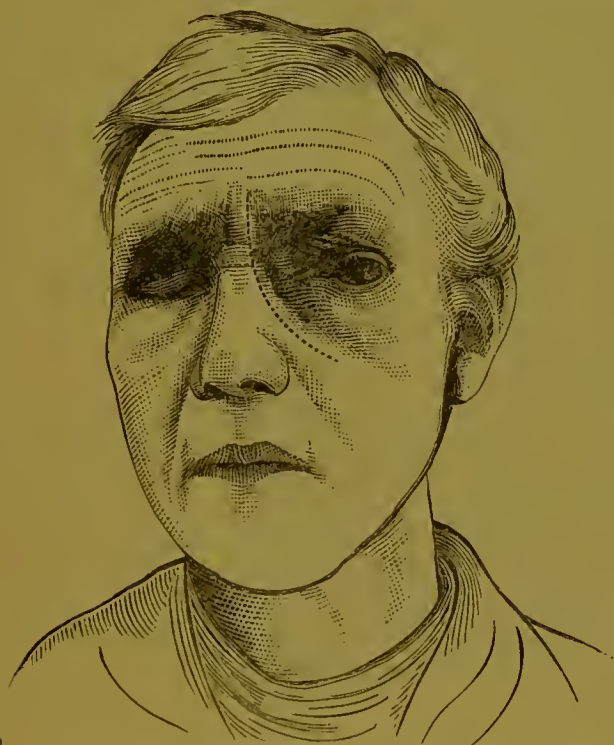


FIG. 6.—Showing Displacement of Eyeball and Line of Incision.

otherwise well developed, but it has no frontal sinuses ; there is nothing but the diploë where the sinuses should be. In the other adult skull which I hold in my hand the frontal sinuses are enormous, but not from disease. There is a very considerable space between the two plates of bone which form the roof of the orbit,

and this condition extends over the entire roof of the orbit from angle to angle.

The sphenoidal sinuses are also sometimes completely absent. In cases of extreme development of the sphenoidal sinuses, the latter may send processes into the great and small wing, the pterygoid process, the anterior and posterior, and the pars basilaris of the occipital bone (Zuckerkindl).

Then the sphenoidal sinuses may communicate with a cavity abnormally developed in the vomer (P. Langer).

Virchow has directed attention to the bearing of premature synostosis of the bones of the base of the skull, especially the basal portion of the sphenoid and occipital bones, on the further development of the skull; showing that the bones of the base of the skull are thereby restricted in their development, the sella turcica being narrow and short, the ethmoid flat, and the pneumatic cavities narrow.

The ethmoidal cells may also be absent.¹

CASE I.—*Osteomata of ethmoidal cells*.—J. A. Andrews. L. C.—, aged forty-eight, mason. In September, 1886, patient was struck on his right eye with a chip of stone. Cornea sloughed. Eye became staphylomatous, and was enucleated at the New York Eye and Ear Infirmary. Left eye was injured with a chip of stone in 1883, the result being a dense leucoma of cornea. An iridectomy was performed on this eye at the New York Eye and Ear Infirmary in August, 1886, with the hope of improving the vision.² On examination a hard, unyielding, crescentic-shaped growth, irregular in outline, was found at the inner lower angle of the left orbit (see Figs. 6 and 7). Eyeball was displaced outward and forward and was restricted in all its movements. There was no pain

¹ A recent publication by Langer and Tyrmann, *Die Krankheiten der Keil-Höhle u. des Siebein-Labyrinthes und ihre Beziehungen zu Erkrankungen des Sehorganes*, contains a very instructive chapter on the anomalies of the ethmoidal and sphenoidal sinuses.

² Patient was admitted to Charity Hospital, January 28, 1887.

in or about the growth. Patient counted fingers at two feet. Voice nasal. Was very deaf (both ears) from chronic adhesive catarrh of middle ear. There was no history or evidence of syphilis. So far as could be ascertained, the growth had existed for five or six years. Diagnosis: Osteoma of orbit; probably of ethmoid.

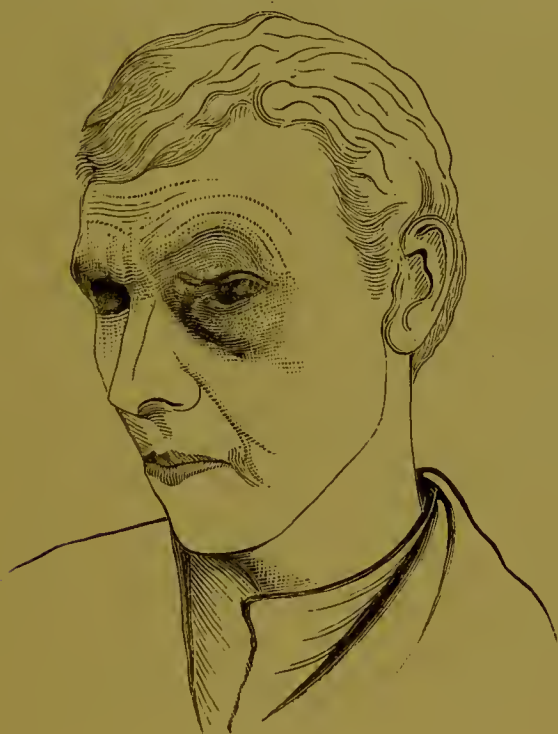


FIG. 7.

February 28, 1887.—Under strict antiseptic precautions the operation for the removal of the growth was performed as follows: A crescentic incision was made, from the middle of root of nose to a point just below the tumor, terminating at middle of lower border of orbit (see Fig. 6). The tumor was covered with a thin, slightly vascu-

lar membrane, which was so tense that on being incised over whole extent of growth it at once parted from the latter and exposed a nodular bony growth, which overhung the inner lower margin of orbit and passed inward to the bottom of the orbit. Having made out that the base of the tumor was composed of cancellous bone, and extended downward into the nasal fossa, the bones of the orbit, in which it was locked, were cautiously chiselled away sufficiently to loosen the growth, with the hope of then shelling it out ; but the tumor extended so far into the orbit that the orbital portion was first chiselled away at its base and the remaining portions, which intruded into the nasal fossa, were removed in pieces with bone-forceps. There was considerable bleeding during the operation, but this was stopped before closing the wound. The periosteum was united with catgut sutures over the gap left in the orbit after the removal of the tumor, and the external wound with silk sutures ; a small opening being allowed at the lower extremity of the wound for drainage, a piece of catgut being inserted there. The whole was covered with bichloride dressing and compression made with a bandage.

Dressing removed on March 4th, for first time. Wound had healed by first intention. Vision = $\frac{20}{200}$. Patient could now move the eye in all directions, there being no displacement of the ball. Complained of slight feeling of numbness of forehead, otherwise he feels "unusually well." In a few days patient was up and about the ward.

July 6, 1887.—Patient continues to do well.

The tumor was composed (see Figs. 3, 4, 5) of a thick shell of dense, ivory-like bone ; its base being broad and made up of cancellous bone. The apex of the tumor passed back into the orbit to the sphenoidal fissure. Measurements : Antero-posterior, 50 mm. ; and 50 mm. through the thickest portion.

CASE II.—Bowman ("Pathological Transactions," 1859, vol. xi., p. 265) removed an ivory exostosis springing from the lamina papyracea, in a man thirty years

of age. The tumor had developed during eight years, and displaced the eyeball outward and slightly forward. Ophthalmoscopic examination showed the optic disk to be as red as the rest of the fundus, and could only be recognized by the passage over it of the retinal vessels. The tumor (shown in drawing) was a nodulated, tuberous growth of solid bone. On section it was found slightly porous near pedicle, but not cancellated, and generally exceedingly dense. There was a deep groove in the tumor above, made by the superior oblique muscle. On the supposition that the tumor might possibly be an abscess or a cyst, an attempt was made to puncture it, but without success, as the tumor was evidently of a bony nature. The tumor was broken away from the inner wall of orbit by an elevator, the pedicle (by which it was afterward proved to be attached) being snapped off short. The lids became greatly swollen after the operation, but this soon subsided. In fourteen days the wound was closed and sight perfect. Two months after the operation the optic nerve was normal in appearance and eyeball natural in position and function. (See, also, specimens, "Philosophical Transactions," 1799, vol. lxxxix., p. 239.)

CASE III.—Brassant (spontaneous exfoliation). The patient was a woman, sixty-five years of age. Fifteen years before, a lachrymal fistula had been unsuccessfully operated on. A bony growth, the size of a hen's egg, developed at *inner angle* of orbit, which displaced the globe entirely forward. Caustics were applied, which, in course of three to four months, gave rise to spontaneous exfoliation.

Spöring ("Abhandlungen der Königlich-Schwedischen Akademie der Wissenschaften," 1778, iv., 206; translated by Kästner). The bony tumor developed at *inner angle of orbit* in a patient twenty-one years of age, forcing the globe out of the socket. A surgeon had made an unsuccessful attempt at extraction. A peasant applied a caustic, which gave rise to intolerable pain and fainting

during twelve days. The caustic was again applied, and in the following spring the tumor, the size of a hen's egg, and present for fourteen years, fell off spontaneously.

CASE IV.—Lucas (*Edinburgh Medical and Surgical Journal*, 1805, vol.i., p. 405). A girl, twenty-eight years of age, received a blow from a cow's horn on the upper and inner angle of the orbit of left eye (only a contusion). At this spot a bony tumor developed, displacing the globe outward. Lucas made an incision, but no attempt to remove the growth. Nine months subsequently the tumor had become so loose that it was readily extracted. It weighed 24 Gm. The tumor was noticed a few days after the injury, and had been present for some time previous to the accident, but the connection between the traumatism and the development of the tumor was undoubtedly a coincidence.

CASE V.—Maisonneuve (*Gazette des Hôpitaux*, 1863, p. 458, three illustrations). The subject of this famous case was a male, seventeen years of age. An ivory exostosis grew from the inner medial wall of the orbit; in the course of one year it filled the whole orbit, pushing the eyeball completely out of its socket. An incision was made along the inner margin of the orbit, and the growth was detached from its periosteal covering with the fingers and blunt instruments. With the same instruments the tumor was lifted from its base and removed. The eye was replaced, and gained perfect mobility and sight. Wound healed by first intention, and without fever. The tumor weighed 90 Gm.; its antero-posterior dimension was 60 mm.; its transverse diameter, 40 mm.; its vertical diameter, 70 mm.; its greatest circumference was 170 mm.; its smallest, 140 mm.

CASE VI.—Maisonneuve (*Gazette des Hôpitaux*, 1853, p. 383). The growth appeared without assignable cause, at inner angle of orbit, in a man twenty-two years of age, in four months filling the medial two-thirds of the orbit and forcing the eyeball out of its socket. Maisonneuve removed the growth with hammer and chisel. Tumor

weighed 28 Gm. Measurements: Sagittal diameter, 5 cm.; transverse and vertical diameter, 4 cm. Healing per *primam*. Function of eye completely restored (see Fig. 8, *a*, *b*).



FIG. 8.—Maisonneuve's Case of Osteoma of Ethmoid Cells.

CASE VII.—Letenneur (*Gazette des Hôpitaux*, 1871, p. 462). Woman, aged forty-nine. Tumor appeared at *inner angle* of left orbit; filled left medial half of orbit in eighteen months. Tumor was the size of a walnut. Greatest diameter, 5.4 cm.; consisted externally of a thin layer of compact substance; internally, of a somewhat spongy substance. Recovery, with good sight, after removal of the tumor with drills and chisel.

CASE VIII.—Burow (cited by Bornhaupt, *loc. cit.*, p. 619). A bony nodule, size of a pea, appeared at *inner angle of right orbit*, in a woman at the age of twenty-eight, and forced the eyeball completely out of its socket. Patient carried this growth for twenty-six years, the increase in size of which was very gradual. Four years before the operation for the removal of the growth, patient was gored in right eye by a cow; panophthalmitis and a chronic suppuration followed, gradually loosening the growth, which was readily removed. Tumor weighed 55 Gm.;

was throughout ivory-like. The bony substance was rich in bone-corpuscles and Haversian canals. Measurements: Vertical, 5 ctm.; from right to left, 5 ctm.; 3 ctm. thick.

CASE IX.—Tweedy ("Ophthalmic Hosp. Reports," 1882, vol. x., p. 303). The patient was a man twenty-five years of age. Left eyeball had been prominent for two years before patient consulted Tweedy. No pain in eyeball itself or in the parts around it; the globe was pushed downward and outward. The tumor was of bony hardness, occupying the *inner* part of the orbit from mid-orbital ridge to the situation of the lachrymal sac. Movements of the globe not much restricted. Vision of left eye = $\frac{20}{20}$, notwithstanding the presence in this eye of a well-marked optic neuritis, characterized by great œdema of the disk and enlargement of the veins. Vision of right eye, normal. An incision, one and a half inch long, was made through the skin and orbicular muscle, along the superciliary ridge and opposite the base of the tumor. The tumor was semi-globular in shape, and filled the upper and inner part of the orbit in front, and extended backward as far as the finger could reach. The periosteum was incised close to the orbital margin, and stripped off the tumor from before backward by means of a raspatory. Several ineffectual attempts were made to penetrate the base of the growth, but the bone was so hard that no impression could be made on it; the edges of the chisels were soon spoiled; Tweedy then used drills. Thus the orbital portion was removed; the remaining portion of the tumor was not removed because of the length of time the operation had lasted (two hours). Patient did well, and, a week after the operation, got out of bed and seemed to be in perfect health. Three weeks after the operation there was scarcely any discharge from the wound, and no pain or discomfort. Exophthalmos remained unaltered. Patient continued to do well until the morning of September 2d, just four weeks after the operation, when he com-

plained of pain on the top of the head. Temperature suddenly rose to 102° F., and pulse went up to 80° . These symptoms increased rapidly, unconsciousness set in, and the patient died on the following day, September 3d.

The necropsy showed general basilar meningitis, with lymph in the fissure of Sylvius and at anterior part of pons Varolii. The brain in immediate contact with the tumor was in a state of red softening, being semifluid, with some puro lymph on its surface at the summit of the bony mass. Left optic nerve was stretched across a groove in the tumor at the posterior part. The greater part of the tumor was in the left anterior cranial fossa. It originally sprang from the frontal sinus and had grown chiefly upward. The roof of the sinus in part extended over the tumor, and had been in part absorbed by it. There were a few semitransparent polypoid growths in the frontal sinus. The tumor reached one inch above the orbital plate of the frontal bone, and extended for that distance into the left anterior lobe of the brain. The tumor measured, from before backward, two inches; it also sent processes, half an inch long, downward into the left nasal cavity; backward it had forced its way into the inner end of the great sphenoidal fissure.

CASE X.—Busch ("Chirurgisch Beobachtungen," 1854, s. 22). Woman, thirty years of age; at age of eleven a hard growth had appeared at inner angle of right orbit. In nineteen years the growth had increased so much that it filled the entire orbit, displacing the eyeball *upward* and *forward*. Busch sawed a groove around the base of the tumor, into which he passed a chisel, and easily detached the growth. *Upward* and inward a portion of the tumor remained, which Busch treated with the actual cautery. Tumor was externally ivory-like; internally, spongy. Healing by granulation.

CASE XI.—Knapp (*Archives of Otology*, 1884, vol. xiii., p. 51). A woman, forty-seven years of age, consulted Knapp for nasal polypi and orbital tumor (on nasal side of orbit), as large as a cherry, of bony hard-

ness, and immovably connected with the os planum. Eyeball was slightly displaced, but otherwise not affected. The amount of polypi removed by snare was sufficient to fill a three-ounce bottle. A curved incision was made from the junction of the middle and inner thirds of the brow along the orbital margin, toward the nose, down to the inner lower corner of orbit, which exposed an ivory tumor piercing the os planum. The tumor was removed with chisel and mallet. Frontal sinus was very considerably enlarged, and contained a mucous polypus. Death occurred on the fourth day after operation from acute purulent septo-meningitis. *Ethmoid cells*, on both sides, were filled with polypi in all their numerous recesses. Tumor measured 15 mm. at its base, 27 mm. vertically at its orbital end, and from 12 to 15 mm. antero-posteriorly.

CASE I.—*Osteomata of the frontal sinus*.—Andrews, J. A. Mary L. H.—, aged nineteen, consulted me in the spring of 1883. She had felt a small hard swelling, about the size of a pea, at the inner angle of her left orbit about one year before. There never had been any pain in this



FIG. 9. — Author's Case of Osteoma of Frontal Sinus. Actual size.

region; she had simply felt the slight swelling in the region indicated, and as there was nothing like it on the other side, she "thought she would consult a doctor about it." The movements of the left eyeball were normal. Vision was likewise normal. At the inner upper angle of the orbit could be felt a small hard prominence, about half the size of a Lima-bean. It occasioned no deformity and was painless. The diagnosis of orbital exostosis was made, and, from the situation of the growth, it was suspected to spring from the frontal sinus. Based on the knowledge that exostosis of the frontal sinus may be of large size, even where the orbital portion is still quite small, the patient was advised

to undergo an operation for the removal of the growth at once. Six weeks subsequently the operation was performed in the following manner :

The parts about the eye were washed with plain water. A curved incision was made from the inner third of the superciliary arch, along the margin of the orbit below the eyebrow, to a point just opposite the insertion of the internal canthal ligament. On reaching the tumor it was seen to be covered with a thin, slightly vascular membrane, which parted from the bone immediately upon being incised over the full length of the growth. The tumor was very hard, the size of half a Lima-bean, and seemed to spring directly from the wall of the orbit ; but on stripping the periosteum from the base of the tumor, a flat probe could be inserted between the tumor and the wall of the orbit, giving the impression of a constriction at this point. I drilled (Archimedean drill) into the neck of the growth, and determined that this portion was not made up of cancellous bone-tissue, but was compact bone. I next made out that this orbital growth was only a portion of a growth which seemed to occupy the frontal sinus, this being determined by means of a fine probe passed between the neck of the growth and the wall of the orbit, through a small hole which I made in the latter for this purpose. I next proceeded to expose the tumor by cautiously chiselling away the bone surrounding the anterior superior portion of the tumor, just below the pulley of the superior oblique muscle, carefully avoiding that important part, and made sure that I was entering the frontal sinus. This having been done, a probe showed that the tumor extended upward and backward. I freed the growth from the lachrymal bone and os planum by attacking those bones with the chisel and mallet. I next raised the tumor from its bed with bone-forceps, and carefully detached it from the soft parts with blunt-pointed scissors.

The whole mass was then removed without any further difficulty. In rotating the tumor in the frontal sinus, I must have severed its connection with the frontal bone,

for there was a fresh rough spot on the tumor, and also on the septum of the sinus, evidently the seat of attachment of the growth.

I found that I had destroyed a large portion of the os planum. The periosteum was stitched over the gap in the bone with catgut sutures, and thread sutures were applied to the wound in the skin. Healing took place by first intention, and patient has continued to do well ever since.

The tumor was oblong and nodular, and composed throughout of ivory-like bone. Measurements: Longest diameter, 42 mm.; through centre, 30 mm. (see Fig. 9).

CASE II.—Hilton ("Guy's Hospital Reports," 1836, vol. i., p. 493, illustration) describes the case of a woman, aged thirty, in whom a large bony growth had developed between the nasal and orbital cavity, on the left side, which had destroyed the eyeball. The growth made its appearance when the patient was thirteen years old; seventeen years later, the tumor *became loose through suppuration and fell off*. The turbinated and cellular apparatus on the left side of the nose was destroyed; the septum nasi was pushed toward the right side, obliterating the right nostril; the left orbit was forced outward. The inner wall of the orbit was next displaced and pressed upon the eyeball, which yielded to the pressure and burst. The tumor did not extend backward toward the pharynx. The whole mass sloughed away, neither pain nor bleeding attending the separation; but a large chasm was left, which opened posteriorly into the pharynx, being bounded below by the nasal surface of the hard palate and floor of the left antrum Highmori, above by the left frontal sinus and left half of cribriform plate of the ethmoid bone, internally by the septum nasi, which presented a concave surface with a small opening through it, a lower part communicating with the left nostril, and externally by the left orbit. There remained an opening in the face, previously occupied by the tumor, exposing the pharynx and hard and soft palate.

The tumor weighed $14\frac{3}{4}$ ounces. Its greatest circumference measured more than eleven inches, and its least, nine inches.

CASE III.—Middlemore (cited by Demarquay, "Traité des Tumeurs de l'Orbite," p. 63) attempted to remove from a woman of twenty-eight a bony tumor, situated at the superior inner angle of orbit, almost filling entire orbit, displacing eyeball completely outward, but without disturbing its vision. Tumor was covered with periosteum. Did not succeed in extracting tumor; the wound suppurated, and nine months later the tumor was loose and removed without difficulty. Dimensions of tumor: Length, $1\frac{1}{2}$ inch; circumference, $2\frac{5}{8}$ inches; weight, $1\frac{1}{4}$ ounce. Recovered.

CASE IV.—Hutchinson ("Illustrations of Clinical Surgery," 1875, fasciculus i., pl. i., p. 9). The patient was a woman, aged fifty, under the care of Mr. Borlase Childs in 1859. The history showed that the tumor began to grow in early life, and had projected first from the nasal side of the orbit. The eye had been destroyed by the large nodular mass of ivory-like bone, which filled the orbit and projected over the cheek; the tumor was quite bare of soft tissues; it had undergone necrosis and become loose (see Fig. 10). At the operation the tumor was found to be movable, having no bony connections, being simply embedded in the distended orbit. The walls of the orbit had been destroyed by absorption, and nothing but fibrous structures (dura mater) separated the mass from the brain. The orbit was greatly enlarged, and would have contained a fist. The frontal sinus on the right side appeared to have been destroyed, and two fistulæ passed above it and opened near the middle of the forehead. At the operation, Mr. Childs did not succeed in getting at the base of the tumor, but sawed off all that projected. Its structure was so hard that several saws were broken. Hutchinson thought that it was the violence done to the growth at this operation which led to its subsequent necrosis and separation. After removal the patient

did well, and the cavity underwent considerable diminution.

CASE V.—(*Ibid.*, p. 10).—Patient was a young man. The tumor in the frontal sinus intruded into the orbit, displacing the eye downward and outward. Hutchinson trephined frontal sinus and cut away its walls, exposing a large white ivory-like growth, much nodulated on its



FIG. 10.—Hutchinson's Case.

surface. The pedicle was broken through without much trouble, and the mass was taken away. Good recovery ensued; but two years later the man again applied to Hutchinson on account of a similar growth on the opposite side; and in removing this the dura mater behind the mass sustained slight injury, and death followed. Absorption of the posterior wall of the frontal sinus had been induced, leaving nothing but dura mater.

CASE VI.—Paget ("Surgical Pathology," p. 535; specimen in the Museum of St. Bartholomew's Hospital, Series B, No. 316). Patient was a girl, aged twenty. Showed exophthalmos, due to a bony growth projecting at the anterior *upper and inner angle of orbit*. It had been observed protruding from the eye for three years, regularly increasing, and producing severe pain in the eyeball and about corresponding side of the head and face. A portion of the growth was sawed off with great difficulty. The partial removal of the tumor was undertaken, with the hope that the disturbance of its growth might lead to its necrosis and separation. The patient died from suppuration in the membranes of the anterior part of the cerebrum.

CASE VII.—Turner (Preparation 546, Anatomical Museum of University of Edinburgh). The bony growth found scarcely any external projection above the orbit, although it projected into the inner wall of this cavity. The frontal sinus was much expanded, and opened by a large aperture into the roof of the orbit. Appears to have sprung from the inner table of the orbital plate of the left frontal bone, and caused a considerable indentation in the anterior end of left frontal lobe of the cerebrum.

CASE VIII.—Arnold (*Virchow's Archiv*, 1873, Bd. lvii., p. 148). Case of a man, aged twenty-four. The tumor had grown steadily for five years, and first made its appearance on the forehead above the nose. At the time of the operation the tumor was hard and nodular, occupying the middle of the forehead from the hair to the root of the nose, and filled the greater part of the left orbit. The base was as large as the palm of the hand, and was surrounded by a bony ridge. There were soft places on the upper periphery of the tumor. At the places which, on palpation, seemed soft were translucent, very vascular gelatinous bodies (cysts) the size of a pea—especially numerous at periphery of growth.

The anterior wall of the frontal sinus was first disturbed, so that the tumor, the size of a hen's egg, projected above the plane of the middle of the frontal bone ;

on the left side it had also broken through the roof of the orbit, lachrymal bone, and the os planum of ethmoid bone, and passed into the orbit at these parts. The greater part of the bony septum of the nose on the right side, and on the left side the upper middle turbinated bone, were destroyed by the pressure of the growing tumor. The anterior portion of the lamina cribrosa, the perpendicular plate of the sinus of ethmoid, were also disturbed by the growth of the tumor, which here projected through several openings into the posterior, *i.e.*, upper wall of the frontal sinus, into the cranial cavity. There was no visual disturbance. Professor Simon removed the prominent part of the tumor on a level with the anterior surface of the frontal bone with the saw and chisel, and some of its processes were removed with bone-forceps. Patient had high fever during first three days after the operation ; felt easy for next week. On the twelfth day after the operation brain symptoms set in—delirium, paralysis of some cerebral nerves, deep coma, and death. The autopsy showed that a portion of the tumor had been left projecting from the posterior face of the frontal bone into the cranial cavity. Both frontal sinuses were immensely distended. There was purulent meningitis and abscess in the left frontal lobe, which had perforated into the left lateral ventricle. The tumor was composed wholly of bone-tissue, and in its peripheric parts it was very compact and ivory-like ; in the deeper parts more spongy, and quite rich in diploëtic substance. The tumor was covered with a delicate membrane. The dimensions were : Vertical, 90 mm. ; transverse, 75 mm.

CASE IX.—Badal ("Bulletins et Mémoires de la Soc. de Chir. de Paris," 1884, tome x., p. 603 ; reported by M. Chauvel). The patient was a man aged twenty-four. A hard tumor appeared in 1880 at supero-internal angle of right orbit ; had progressed slowly during two years, and resisted all medication. In 1882 there was an enormous exophthalmos, with epiphora and intense conjunctivitis. Vision reduced one-third ; diplopia ; discoloration of

optic disk. The tumor wholly filled right orbit. No history of syphilis; no pain. Removed tumor with chain-saw, elevator, and bone-forceps. Tumor measured 35 mm. in height, 40 mm. in depth, 60 mm. in breadth. It presented numerous prolongations toward ethmoidal cells, sphenoidal fissure and sphenomaxillary fissure, and superior portion of orbit. The surface was irregular, mammillated, and its numerous projections lodged in the neighboring cavities, perforating or destroying the bony walls of the orbit. The brain was exposed at one point, and a portion of the cerebellar matter followed the ablation of the tumor.

The operation lasted an hour and a half; one hundred and fifty grammes of chloroform were used; and a good deal of blood was lost at the operation. Operation was followed by congestion of lungs. No local reaction. Healing assured on the fifteenth day, when the eye had recovered a part of its movements, but there was still an absolute paralysis of accommodation, and the acuity of vision was not restored. At the end of one year diplopia had disappeared.

CASE X.—Knapp (*Graefe's Archives*, 1861, vol. viii., p. 230). The patient was a boy aged fourteen. The exostosis extended from the roof of the orbit toward both the orbital and cranial cavity. It had steadily and perceptibly grown for two years, producing exophthalmos, and, ultimately, repeated attacks of an irritative cerebral affection, which lasted six weeks. Knapp succeeded in removing, with Heine's saw, only a part of the orbital portion of the tumor. Moderate suppuration set in. The patient died eleven weeks after the operation, *from purulent meningitis*. The entire tumor was a round, nodular, ivory-like exostosis the size of a goose-egg, which filled part of the ethmoid cells, the left frontal sinus completely, the right partially, in two small places perforated the anterior table of the frontal bone, and very extensively the upper posterior table, occupying the whole left and a part of the right anterior

cerebral fossa, and nearly one-third of the left middle fossa.

Its diameters were 59 mm., 56 mm., and 54 mm., respectively. It was covered everywhere with a thickened capsule of periosteum, in which, he states, he was able to follow the direct formation of bone from connective tissue.

CASE XI.—Knapp ("Tr. Inter. Ophthal. Congress," 1876, p. 52). The patient was a man aged thirty-six. Nineteen years before seen by Knapp patient first noticed a hard swelling at the root of his nose, which slowly but steadily increased until it attained the size of a small apple, situated on the root of the nose, and sending a prolongation the size of a walnut into the inner wall of each orbit, crowding the eyes toward the outer walls of their sockets. There had never been pain, disturbances of sight, nor other inconvenience connected with the tumor. The tumor was removed piecemeal with the chisel and mallet, the body of the growth being thus attacked with these instruments. There was some suppuration in the right corner of the wound, but it gradually ceased, and the patient was discharged, cured, four weeks after the operation.

CASE XII.—Roux ("Mémoires de l'Académie Royale de Médecine," 1871, I., iii., p. 4) attempted to remove an exostosis of the right frontal sinus, but could not complete the operation, and the young man died. The specimen was removed by Nélaton and deposited in the museum of the Val-de-Grâce Hospital.¹

CASE XIII.—Jobert (*ibid.*, p. 18, and Pl. ii., Figs. 1 and 2) made an unsuccessful attempt to remove an exostosis of the frontal sinus with the trephine. In spite of its great dimensions, the tumor did not adhere at any point to the cranium, but it was firmly wedged in the region which it occupied. Jobert thought that the ex-

¹ See Pl. II., Figs. 3 and 4, Dolbeau, Mémoires de l'Académie Royale de Médecine, 1871.

treme development of the growth made its successful removal almost impossible. At one point (very limited) the tumor seemed to blend with the frontal face of the sinus. Dimensions: Height, 50 mm.; length, 40 mm.; antero-posterior measurement, 30 mm. Irregular surface. Tumor occupied anterior cerebral fossa. Fatal.

CASE XIV.—Dolbeau (*ibid.*, p. 12). The patient was a man aged twenty-one. No syphilis. For three years deformity in right fronto-orbital region. Tumor presented at *inner upper angle of orbit*, and pushed the *eye outward and downward*. At the end of three years he became subject to pain in right side of head; noticed at same time augmentation of volume of frontal region (slow but progressive). No convulsions nor paralysis. *The orbit was invaded only ten months before the operation*. An incision was made near to and parallel with the median line, then a horizontal one along the upper orbital margin. The opening in the frontal bone through which the tumor had intruded into the orbit was enlarged, and the tumor, which was loose in the frontal sinus, was seized with bone-forceps, a piece of it being broken off; it was then seen that the tumor was composed of a bony shell of ivory hardness, with cancellous vascular tissue in the interior. The remainder of the growth was removed piecemeal with bone-forceps. The last portion removed seemed to indicate that the tumor was implanted into the septum of the frontal sinus. On smoothing this small rough surface with the rongeur, an artery (A. nutritiva) spouted and had to be obliterated with a globule of wax. A pledget of lint was placed in the cavity of the sinus, the flap of skin put in place, and covered with a wet compress. The operation was followed by ecchymotic swelling of the lid of right eye and headache. On second day headache increased, and there was some delirium; pain in the region of the *left* frontal sinus, and œdema of the eyelids on this side. Suppuration commenced on third day; on fourth day cephalalgia was very intense, chiefly in occipital region, and patient was

slightly somnolent. No vomiting. Patient did not begin to improve until ninth day. Got up on nineteenth day, and was discharged, cured, thirty-one days after the operation. The movements of the right eyeball were normal, vision intact, but the globe had not completely returned to its normal position, as it was situated on a lower plane than that of left eye. The operation was completely successful. The tumor was formed of a shell of compact bone-tissue, its interior filled with spongy bone-tissue. No trace of a capsule of cartilage.

CASE XV.—Banga (*Deutsch. Zeitschr. f. Chirurgie*, 1874, iv., p. 486). A youth, aged eighteen, had received a blow on the left eye with the handle of a whip, six years previous to his consulting Professor Socin, in Basle. Three years later he first noticed that his left eye was *swelled*, and was more prominent than the right, which continued without pain until his visit to Professor Socin's clinic, at which time the left eye was pushed forward, downward, and outward by a hard tumor at the upper orbital margin. Left upper eyelid was greatly swelled and discolored from distended veins, and covered the tumor entirely. The tumor was hard as stone, immovable, and painless, with a horizontal diameter of 5.0 ctm. ; vertical, 4.5 ctm. ; conjunctiva, bulbi, and palpebrarum only slightly injected ; cornea slightly cloudy, hence a good ophthalmoscopic examination was not obtainable. Vision, L. E. = $\frac{1}{20}$. Excursion of the eyeball restricted to slight elevation, rotation, and downward motion. Eyelids almost immovable. Vision of R. E., normal. The conjunctiva became slightly injected as soon as right eye was uncovered ; however, the right eye became more injected, and watered. No cerebral symptoms ; also no signs of growth of tumor into nasal cavities. At the operation, Professor Socin found that the superior oblique muscle had made a groove into the tumor. The tumor was readily loosened with mallet and chisel and lifted out with bone-forceps. Roof of orbit was intact. Exophthalmos was reduced to about

one-third of its previous amount. Ice-bladder applied over the wound. In first week there was little reaction; secretion moderate. On eighth day, intense headache, chilliness set in, with subsequent high temperature, debility, violent and persistent vomiting, great anxiety, convulsions, sopor, and two days later, on tenth day after operation, death. Autopsy showed diffuse purulent meningitis, particularly in anterior part of left hemisphere. In centre of base of left frontal lobe was an abscess in the brain the size of a pigeon's egg, surrounded by punctate hemorrhages. Dura thickened, covered with discolored pus. The extirpated tumor was very hard, and the size of a hen's egg; weight, eighteen grammes. The surface of the tumor was in part smooth, in part finely porous on the surface, like pumice-stone, and covered on all sides with periosteum. Tumor consisted externally of ivory-like substance, internally of cancellous tissue filled with a vascular, fatty pulp. Anteriorly, the floor of the frontal sinus is absent on left side. Microscopically: The ivory part of the tumor consisted of symmetrical bony tissue, with few Haversian canals, interlamellar substance, and a few bone-corpuscles. Inward and upward, close to the infundibulum, was a rough place on the frontal bone corresponding to a similar one on the tumor, where the tumor with a narrow pedicle was believed to have originated.

CASE XVI.—Arnold (*Virchow's Archives*, vol. lvii., p. 146). The growth showed itself by a small prominence at the inner angle of the left orbit, where there was a short fistulous ulcer secreting at times some thin pus. Left frontal sinus was completely filled with a tumor which had destroyed a part of its anterior wall and the anterior half of the roof of the orbit. The tumor was fixed on the posterior plate of the frontal sinus. It was nodular and slightly movable, measuring, laterally, 4 cm.; antero-posteriorly, 3.5 cm.; vertically, 2.5 cm. It was covered with a delicate connective-tissue membrane. The edges of the bones perforated by the tumor

were sharp and jagged, the result of the destruction from pressure by the growth. The cause of death is not given. The history is defective.

xvii Caspar Hoppe (quoted by Bornhaupt, *loc. cit.*, p. 601). Busch operated on a female, aged twenty-two, in whom, seven years before, a bony tumor had developed immediately above the root of the nose under ordinary symptoms of osteoma of frontal sinus. The tumor was removed, but death ensued thirteen days after the operation from abscess of the brain. The tumor filled both frontal sinuses and the ethmoidal cells, and a portion the size of a pigeon's egg projected through the anterior cranial fossa into the cranial cavity.

CASE XVII.—Bryant (*British Medical Journal*, 1872, vol. ii., p. 631). The patient, a man, aged twenty-four, first observed a slight protrusion of the right eyeball five years before, which had slowly but surely increased. Bryant first removed the growth from the orbit by turning down the eyeball and its appendages, and then chiseling and sawing it away piecemeal. Its aggregate size in the orbit was that of a small orange. He then removed the exostoses from the frontal sinus in the same way. The growth appeared to arise by a pedicle from the anterior plate of the frontal bone. The result of the operation is not given.

CASE XVIII.—Adelmann ("Beiträge zur med. und chirurg. Heilkunde," Bd. ii., s. 172, quoted by Bornhaupt, p. 601). Patient was a woman, aged twenty-three. Tumor partially removed. Meningitis on fifth day after the operation, from which she recovered, and left the hospital six weeks later, with a fistula.

CASE XIX.—Birkett ("Guy's Hosp. Reports," 1871, p. 505, plates i., ii., iii.). Patient was a girl, aged fifteen. When thirteen years old, patient had scarlet fever six weeks, after which her friends noticed a swelling on the forehead, but the girl herself stated that an altered position of the left eyeball first attracted her attention and that the frontal swelling appeared subsequently. The

displacement of the eyeball had existed only about nine months prior to the operation.

The left upper eyelid was depressed and could not be perfectly raised, and the fissure between the lids inclined obliquely downward and outward. The left eyeball was on a lower plane than the right; it was also everted. The veins on the surface of the upper eyelid were dilated and the cutaneous surface congested. The tumor spread into the angle of the orbits, on both sides of the root of the nose, but projected most into the left. In the centre of the frontal swelling fluctuation could be felt. On exposing the tumor, Birkett found a defect in the frontal bone. The tumor sprang from the posterior wall of the sinus. The operation was not completed for fear of opening the cranial cavity. Patient died thirty-eight days after the operation, of purulent meningitis. The tumor extended transversely and antero-posteriorly into the middle of the anterior fossæ of the cranium, hiding the crista galli. Dura mater was united very firmly to one portion of the growth, and on the right side, the brain also. There was an abscess (chronic) in the anterior lobe of the left hemisphere. The left orbital plate of ethmoid bone was destroyed; the right orbital plate of the ethmoid bone was entirely gone, and so the right frontal sinus was laid open and a piece of the bony growth exposed to view in the right orbit. The growth was composed entirely of the finest and most delicate cancellous bone-tissue.

CASE XX.—Öttingen ("Mittheilungen aus der chirurg. Abtheilung der Universitätsklinik zu Dorpat, 1858," in den Beiträgen zur Heilkunde, herausgegeben von der Gesellschaft prakt. Aerzte zu Riga, 1860, Bd. iv., Tfl. 5). A man, aged twenty-four. When twenty-one years old a bony tumor appeared at upper medial angle of right orbit, by which the eyeball was displaced forward, downward, and outward. Öttingen removed a portion of the tumor, and succeeded in replacing the eyeball, but the patient died in twenty-nine days after the operation, of purulent meningitis.

CASE XXI.—Hewitt ("St. George's Hospital Reports," 1867, vol. ii., p. 14). Case of Lawrence. The tumor appeared to be limited to the inner part of the orbit, but after death dissection proved that the frontal sinus was filled with the growth, which had, moreover, made its way into the cranial cavity.

CASE XXII.—Hewitt (*ibid.*, p. 17). A woman, aged twenty-four, had had exostosis of frontal sinus for several years, situated at the lower part of the forehead and accompanied by head-symptoms. Removal attempted by Professor Regnoli, of Pisa. At the operation, the anterior table of the frontal bone and corresponding parts of the nasal bone and of the ascending process of the superior maxillary, also affected by the exostosis, were removed at the same time. The actual cautery was then applied, necrosis followed, and the dura mater was laid bare. Nineteen months afterward the patient was completely cured.

CASE XXIII.—H. A. Lediard (*British Med. Jour.*, 1882, ii., p. 1252). A sailor, aged thirty-three; tumor said to have been the size of a pea at birth, and was situated between the upper eyelid and eyebrow. Tumor gradually enlarged, inducing destruction of the globe at the age of nine years. The tumor ceased to enlarge at the age of twenty-five, and two years later the skin which had hitherto covered it suddenly gave way. When admitted to the hospital, at the age of thirty three, the tumor was 4.5 by 5 inches, weighed 2.25 ounces; was pediculated; tumor was movable, and an offensive discharge issued from its base; a month later the whole mass became suddenly detached without associated pain or hemorrhage. (Frontal sinus?)

CASE XXIV.—Panas (*Arch. d'Ophth.*, tom. iv., p. 289). A girl, aged eighteen; the exostosis of the right orbit made its first appearance when she was thirteen. It had already been subjected to two operations. The tumor, the size of a hen's egg, occupied the region of the right eyebrow, and extended to the left eyebrow and to the

bridge of the nose. The eye was pushed very much forward, downward, and outward, and possessed merely quantitative perception of light. The optic papilla was atrophic. The sense of smell on the right side was blunted. No cerebral symptoms. Panas made a broad opening in the frontal sinuses, but had to be satisfied with resection of the orbital part of the tumor, since the entire frontal sinus was filled with compact bony tissue. Death followed six days later from meningitis, caused by purulent phlebitis. The neoplasm originated in the orbital wall of the frontal sinus, and extended into the orbit, the ethmoid bone, and the frontal sinuses of the opposite side, and then into the cranial cavity.

CASE XXV.—Knapp (*Archives of Oph.*, 1880, p. 464). The patient was aged forty-eight. Inner part of upper lid slightly prominent and pushed down; conjunctiva and eyeball normal; mobility unimpeded; vision and ophthalmoscopic condition normal. In inner upper corner of orbit there was a tumor nearly as large as a flattened hazel-nut, slightly uneven, abruptly rising from orbital wall and immovable. Curved incision was made from middle of superciliary arch along the lower margin of the brow, down to insertion of inner canthal ligament. The stretched periosteum of tumor parted on being divided, and exhibited the yellowish, shining surface of the tumor, which was of uniform hardness. The tumor showed a slight constriction at its base. Knapp cut a furrow along the supposed cancellous base of tumor with chisel and hammer, and as it did not become loose or movable, Knapp chiselled a regular groove into it ten millimetres deep and twenty-five millimetres in length along the wall of the orbit. Persistent chiselling for three-quarters of an hour showed that he was not reaching the supposed cancellous base, but was carving a furrow into the uniformly compact mass of the tumor itself. It was then evident that the tumor extended beyond the limits of the orbit into the nasal fossæ, the frontal sinus, and, perhaps, the cranial cavity. Being all around in con-

nection with the bony wall of the orbit, and supposing the tumor to have originated in the diploë, Knapp broke down its osseous surroundings with the chisel, the edge of which was held perpendicularly to the wall of the orbit, enclosing the tumor. This was begun at the upper edge of the tumor and close behind the supra-orbital notch, avoiding interference with the pulley of the superior oblique muscle; then along the circumference of the tumor, breaking down the bony plate of the orbit as far as it encased the growth. Having done this from the superciliary notch along the upper inner corner of the orbit down to middle of anterior part of os planum, the tumor became loose. Knapp next carefully detached all the soft parts from the tumor. Having done this on all the surfaces of tumor, the latter lay completely loose in its periosteal envelope, and was drawn out with bone-forceps.

On examining the wound with the finger, the upper half of the os planum and the whole anterior upper inner half of the roof of the orbit were absent; the upper part of the nasal cavity and the whole right frontal sinus lay open, and in the outer part of the roof of the orbit a triangular piece of bone was fractured and freely movable, but was kept in its natural position by the periosteum and dura mater. The fractured bone was not disturbed. The dilated frontal sinus and the opened nasal cavity were found free from other growths. The wound was united by silk sutures, the threads being passed through the skin and periosteum on both sides. At the lower end of the wound, immediately above the internal canthal ligament, a silver drainage-tube was inserted and a charpie bandage applied. The wound healed by first intention. There was no diplopia, and the movements of the eye were natural. The tumor was oval, the size of a large English walnut. Vertical diameter measured 36 mm.; its greatest antero-posterior diameter, 29 mm.; its greatest lateral diameter, 24 mm. Surface uneven, with several nodular projections.

CASE XXVI.—Kundrat (*Wiener med. Blätter*, 1883, No. xlviii.). The tumor extended far into the cranial cavity, therefore it could not be removed. The necropsy showed that the tumor had originated from the region of the lamina cribrosa and the superior inner angle of the roof of the orbit.

CASE XXVII.—Demarquay ("Annales de la chirurgie française et étrangère," t. iii., p. 242). An ivory exostosis, adherent to the anterior plate of the frontal bone, on right and left side. The frontal sinuses had been opened by suppuration. The tumors were complicated with suppurations and polypi. Successfully removed.

CASE XXVIII.—Heister ("St. George's Hosp. Rep.," 1867, vol. ii., p. 14). A soldier, aged thirty-three, had on his forehead an enormous exostosis, which was increasing in size. Heister attacked it with hammer and gouge, and brought it away, extensively laying bare the dura mater, notwithstanding which the patient ultimately *recovered*.

CASE XXIX.—Massey (*ibid.*, p. 18). An ivory exostosis, three inches long and one and one-half inch broad, was removed by Massey from the middle of the lower part of the frontal bone. The tumor was laid bare and a groove made around its base with Hay's saw, after which, by means of a chisel and gentle blows with the mallet, the whole growth was removed bodily. Wound healed perfectly within eight days.

CASE XXX.—Paget ("Surgical Path.," p. 534, specimen in Museum of College of Surgeons, London, No. 795, pictured in Baillie's Morbid Anatomy, fasc. x., pl. i., fig. 2). Tumor was two and one-half inches in diameter, deeply lobed and knotted; filled frontal sinuses and upper part of left orbit, encroaching upon the right orbit, and projecting for nearly one inch on both the surfaces of the skull. In its growth it displaced and destroyed by pressure the adjacent parts of the tables of the skull and the wall of the orbit. The tumor was for the most part hard as ivory, but in its central posterior portion it was composed of very close cancellous tissue.

CASE XXXI.—Bornhaupt ("Archiv f. klin. Chirurgie," 1881, Bd. 26, p. 595, Figs. 1, 2 ; pl. xi.). Girl, aged eighteen. Two years before seen by Bornhaupt, simultaneously with beginning of menses, the left eye began to lachrymate, and, unattended by pain, to be protruded from the orbit, and diplopia set in. A few days before consulting Bornhaupt a phlegmonous process developed in the orbit. The upper eyelid and the region of the inner angle of the orbit were especially swollen, and there was fluctuation in the depth of the orbit. An incision four centimetres long was made at the inner angle of the orbit, and parallel to the orbital margin, by which muco-purulent material was evacuated ; the bone was laid bare, and nodular masses of bone thereby exposed, showing that there was unquestionably a bony tumor. On June 19th the left upper eyelid was very red and œdematous, and left eye ball displaced forward, downward, and outward. Vision, L. E., $\frac{1}{4}$ — $\frac{1}{3}$ of normal. No defect in visual field. Ophthalmoscope showed congestion of retinal circulation, inflammatory opacification of papilla and para-papillary tissue of retina. The movements of the eyeball were restricted in all directions ; the superior rectus seemed most affected. Under treatment with lead-water applications and washing out with a solution of carbolic acid, the swelling of the upper lid subsided, so that firm, nodular bony masses could be felt in the medial half of the orbit, making the diagnosis of an orbital osteoma certain. July 2d, the phlegmonous process exacerbated, so that near the former fistulous opening a puncture had to be made, giving exit to a bloody, muco-purulent fluid. The wound was drained just so soon as the inflammatory phenomena had subsided. Volkmann operated, July 16, 1880, for the removal of the growth. He made a curved incision along the orbital margin, and at the medial border of the orbit a second incision perpendicular to the first, extending about one inch or more. The flap was raised with the raspatory, and the entire upper and medial portions of the orbit, orbital border, and the neighboring

parts of the frontal bone were laid bare. The tumor was then exposed, it being in general spherical, with a few flat nodules, which filled the medial half of the orbit, and passing upward and inward to the orbital margin. At the summit of the tumor there was a mass of ivory-like bone, which was sharply defined from the red, spongy, softer surrounding bone, and showing that the tumor was a *hard osteoma Encapsuled* by a softer bony shell. Accordingly, this shell was removed piecemeal with the chisel. The shell was in close apposition to the tumor, but it was removed, because it was separated from the tumor by a very thin layer of connective tissue.

The frontal sinus contained considerable pus. The tumor was exposed on its medial border, and a strong iron elevator applied behind it, at the site of the spontaneous perforation. By this means the tumor was forced out of its bed, exposing a prolongation of the tumor, which projected into the nasal fossa. The frontal sinus was found to be very much enlarged, and its lining membrane swelled and congested.

In freeing the tumor a good deal of the enlarged frontal bone, *i.e.*, superior orbital border, was chiselled away, so that under normal conditions the cranial cavity would have been freely laid bare. The wound was carefully disinfected, drained, and an antiseptic dressing applied. Healing without reaction. Ten days after operation the patient was dismissed, with wound closed. During this time the disturbance in circulation of retina disappeared. Movements of eyeball normal, but there was still diplopia. Tumor measured, from above downward, 5.8 ctm.; in greatest diameter from right to left, 3.3 ctm.; in greatest diameter from before backward, 3 ctm.; weight, dried, 50 Gm.

CASE XXXII.—Kundrat (*Wiener med. Blätter*, 1883, No. xlviii.) observed an exostosis of the orbit which extended very far into the cranial cavity, therefore it could not (?) be removed. The post-mortem examination showed that the tumor originated from the region of the

lamina cribrosa and superior angle of the orbital roof (frontal sinus?). There had been no symptoms of disease of the brain.

Osteoma of the sphenoid.—The only case of osteoma of the sphenoidal sinus in which an attempt was made at removal by an operation, which I have been able to find in literature, is that described by Spencer Watson ("Transactions of the Pathological Society of London," 1868, p. 310, illustration). The patient was a man, aged twenty-one, in whom an osteoma the size of a fist filled the left orbit, displacing the eyeball upward and laterally, but its movements were tolerably perfect, and the sight was very little impaired. Patient had first noticed a swelling at the inner side of the eye, twelve years before, which gradually increased in bulk for six or seven years. Sir William Fergusson removed the tumor, and found that the principal attachment of the deep part of it was to the body of the sphenoid, above the pterygoid process; there was also a very firm attachment to the upper and inner walls of the orbit. On the third day after the operation the patient became suddenly faint, and rapidly sank.

At the post-mortem examination the brain, with its membranes, was found healthy. Two bony tumors were found lying in the middle and anterior cranial fossæ, the larger of which sprang from the left side of the body of the sphenoid, and was of about the size and shape of a walnut; the other, smaller one was situated at the inner end of the lesser wing of the sphenoid, and immediately above the optic nerve. The optic nerve, although considerably elongated, did not present any other abnormal appearance. The tumor weighed 5,040 grains. Tumor consisted of a superficial ivory-like shell, from one-half to one and a half or two inches thick, and a spongy, vascular nucleus.

Dr. Trimer examined the tumor microscopically, and declared that there was, between the two portions of the tumor, a loose cartilaginous tissue similar to that

seen between the epiphyses and shafts of growing bones ; but the Committee on Morbid Growths did not confirm this statement respecting the finding of cartilage, and they were of the opinion that the tumor had sprung from the periosteum.

Descriptions of osteomata of the sphenoid have been given by Römheld, J. P. Frank, Pech, and in the *Musée Dupuytren*, No. cccvii., p. 437.

CASE I.—*Osteomata of the antrum of Highmore*.—John Howship ("Observations in Surgery and Morbid Anatomy," p. 26, pl. ii., fig. 1). No operation.

CASE II.—Manz (Case I., *Archives of Ophthalm.*, 1873, vol. viii., p. 321).

CASE III.—Hilton ("Guy's Hospital Reports," vol. i., p. 403). In this case the osteoma, originating in the antrum of Highmore, extended into the ethmoidal sinuses. When the patient was a boy, aged thirteen, a swelling showed itself between the orbit and the nasal cavity. After seventeen years the growth became movable ; and after it had existed for twenty-three years the skin covering the tumor suppurated, and the latter was spontaneously exfoliated. The cavity which remained was bounded above by the frontal and ethmoidal sinuses, below by the walls of the antrum of Highmore, and inward by the septum of the nose, which was displaced toward the right. Tumor weighed 440 grs ; the greatest diameter was 11 mm. ; the smallest, 9 mm.

CASE IV.—Duka ("Transactions of Pathological Society of London," 1866, vol. xvii., p. 256, fig. 21, p. 258) removed part of the superior maxillary bone on account of an ivory exostosis of the antrum of Highmore, which had become loose by suppuration. Duka extracted the first bicuspid teeth, and prolonged the incision downward through the upper lip, detached the mucous membrane along the alveolar process, and made a flap. He next removed a triangular piece of bone from the palatine process of the superior maxilla. The tumor was then extracted. The cavity left behind was of great dimensions, the vomer

was absorbed, and the right antrum of Highmore had lost its nasal plate. The wound healed by first intention, and the patient left the hospital on the tenth day. The upper part of the tumor lay in contact with the cribriform plate of the ethmoid; at the lower surface of the tumor was a large nipple-like process, which lay in contact with the palatine process. The anterior part of the body of the tumor presented in the nostril. At the base of this process was a large hole, piercing it quite through. In this *lacuna* was a polypoid mass which contained a nucleus of cartilage, round and flat, like a small-sized lentil. The whole bony mass was composed of eburnous structure, weighing 1,060 grains; its long diameter was nearly three inches; the short, one inch and two lines; and the longest circumference, seven inches.

CASE V.—Michon ("Mémoires de la Société de Chirurgie de Paris," 1851, tome ii., p. 615). The tumor was so intimately blended with the vomer and maxilla that the whole of the former, and a great part of the latter, came away with it. There was no thin pedicle. The tumor occurred in a man, twenty years of age. The tumor had begun to grow when the patient was sixteen years of age. The growth had developed after a blow, right under the right eye. Eye was displaced upward, outward, and forward, the nose being completely displaced toward left side, and the zygoma laterally. Weight, 122 Gm.; circumference, 15.5 ctm.; height, 6 ctm. It was covered (with the exception of the medial surface) with a soft membrane, the mucous membrane of the antrum. Recovery.

CASE VI.—Boyes ("Traité des Maladies Chirurgicales," tome vi., p. 168, Paris, 1818). Exostosis of left maxillary sinus for ten years, which had appeared soon after a venereal infection, which had been followed by secondary symptoms. After having taken one hundred and twenty-eight grains of corrosive sublimate, in less than three months, patient was wholly freed of the exostosis.

CASE I.—*Exostoses of the orbit which originate external to the frontal and other pneumatic cavities.*—Stephenson ("Annales d'Oculistique," 1860, p. 21) removed an exostosis from upper border of orbit in a girl aged eighteen. Tumor had developed in three years.

CASE II.—Windsor ("Annales d'Oculistique," t. xii., p. 211) removed (with chisel) a bony tumor from the upper and lateral orbital wall, in a woman twenty-four years of age. The tumor projected from the upper border of the orbit and pushed the eyeball downward and forward. It consisted partly of bone and partly of cartilage (?). Had grown in fifteen months. Recovery.

CASE III.—Haynes Walton ("Operative Ophthal. Surgery," p. 319, fig. 100). When a child, patient fell downstairs, injuring the *upper orbital border*, at which place a hard, bony tumor formed. When patient was forty years of age the growth occupied the upper edge of the orbit; had a very broad base, its greatest point of projection being two inches. The upper part of the tumor was covered by the eyebrow, which was considerably displaced upward; the lower part touched the eyeball, displacing it downward and outward, the eyeball protruding about one inch beyond its fellow, thereby nearly destroying vision. Tumor was nodular, hard as stone; the skin over it was movable and traversed by a few blood vessels. Walton sawed off the tumor. Recovery ensued, and the sight was completely restored.

CASE IV.—Salzer (London *Lancet*, 1831, vol. i., p. 671). A girl, seventeen years of age, received a blow with a rake, whereby the handle entered the right orbit. About eighteen months after injury, when the wound had been healed for a long time, there appeared a hard, immovable tumor at the upper margin of the orbit, displacing the globe downward and inward, so as to almost touch the left nostril. Sight was not completely destroyed. Four years after the accident, Salzer, after several attempts with the hammer and chisel, then with the trephine, which he applied six times, finally removed the tumor

piecemeal. Tumor was attached by a broad base. Dried, the pieces of the tumor weighed two ounces. Recovery. Sight restored.

CASE V.—Canton, E. (*Medical Times and Gazette*, 1851, vol. xxiii, p. 494). A bony tumor had grown in the orbit of a woman, between twenty and thirty years of age, to the size of a walnut, in seven months, pushing the eyeball forward and outward. No pain was felt; vision was perfect. The orbital ridge on the right side was increased in thickness, and the tumor, continuous with it, passed downward and deeply backward into the orbit. The tumor was detached from the orbital plate with the chisel. Water dressings were applied, and the patient recovered in a week. The tumor was formed, toward the periphery, of compact bone; within, the bone was spongy.

CASE VI.—Törnroth et Ilmoni ("Analecta clinica," t. i., fasc. i., Helsingf., 1851, cited by Bornhaupt: *Archiv f. klin. Chirurgie*, Bd. xxvi., p. 613). Patient, aged fifty, had suffered for five years with gout, when the upper orbit-border became so much swollen that it projected under the upper lid as an oval tumor, which filled the upper lateral portion of the orbit so completely that it was difficult to introduce a sound between the tumor and the swollen lid. The eye was destroyed. Törnroth removed (with Heine's osteotome) the prominent portion of the tumor, which was covered with a firm, callous periosteum, and consisted externally of compact, internally of a spongy substance. Healing took place three months subsequently, after the remaining portion of the tumor had been thrown off by suppuration.

CASE VII.—Weinlechner (*Wiener med. Blätter*, 1883, Nos. xlvi.—xlvi.) operated upon an osteoma of the orbit in a man, fifty-one years of age. The tumor had developed at twenty-six. Eye displaced outward; pronounced exophthalmos; amaurosis. The growth extended into the nasal fossa. In operating, the nasal process of the superior maxilla was removed, and the frontal sinus opened.

Later, polyps and remnants of the osteoma were removed from the nasal fossa. Patient died of erysipelas. Tumor originated in diploë of the orbital roof; measured 24 cm. in circumference, and weighed 281 grs.

CASE VIII.—*Ibid.* Removed with good results an ivory tumor of the orbit, in a girl aged sixteen. Had existed for one year. Twelve centimetres in periphery.

CASE IX.—Hulke (*Lancet*, 1882, vol. i., p. 910, from floor of orbit). Patient was a girl, aged four. Considerable exophthalmos, first noticed fourteen months previously. The eyeball was displaced downward. The bony mass was attached to roof of orbit. An exploratory incision showed the mass to consist of very vascular spongy bone connected with the external angular process and orbital plate of the frontal bone. It extended almost to the apex of the orbit, and had not any definite boundary. "As its removal was proved not to be feasible, the wound was closed. Immediate union occurred, and the child was taken home." The further progress of the case is unknown.

CASE X.—Birnbacher (*Archives of Ophthalm.*, 1883, vol. xiii., p. 404). This was a case of ectopia of the eyeball by osteophytis from roof of orbit, with consecutive pneumatosis of supra-orbital region. Eyeball protruded. Difference in apices of corneæ amounted to about five millimetres. Increase in refraction of diseased eye from $H = \frac{1}{24}$ to $M = \frac{1}{30}$, produced by elongation of optic axis caused by pressure on the globe from above downward by bony ridges. An incision was made under and along the lower border of the brow, commencing at the outer angle of the orbit and reaching nearly over the upper border of the lachrymal sac. Having reached the periosteum in the region of the upper orbital border, it was found to stretch over a pneumatic cavity, forming its floor, and containing two larger ridges and one smaller one, of reddish-gray-colored spongy bone, projecting downward against the eyeball. These ridges had their origin in the mass of fine spongy bone which formed

the roof of the orbit. They extended two millimetres into depth of orbit, and formed therein a comb which was covered with the periosteum of the roof of the orbit. The periosteum of the floor of the cavity mentioned contained hard plates of bone. Birnbacher believed that the site of irritation which caused the growth of the osteophytes was an inflammatory, non-suppurative affection of the frontal sinus, affecting sympathetically the periosteum of the frontal bone and the roof of the orbit.

CASE XI.—Sands (*Archives of Ophthalm.*, 1880, vol. ix., p. 471). Patient was a man aged twenty-two. Three years before the operation he noticed a slight protrusion of the right eye, accompanied with deep-seated orbital pain, headache, and vertigo. The exophthalmos had gradually increased since then, and the right nasal passage had become obstructed with a firm mucous polypus, having no connection with the orbital tumor, but the latter had caused some narrowing of the nasal passage, the sides of which were closely approximated. No positive diagnosis was made, although the coincidence of exophthalmos with nasal obstruction led to the suspicion that the tumor was connected with the antrum. A triangular flap, having its apex near the inner canthus, was reflected so as to expose the interior wall of the antrum. This was cut away sufficiently to admit the finger, when it was ascertained that the cavity was empty. The inferior edge of the orbit was gradually removed until the index-finger could penetrate the orbit deeply enough to feel the morbid growth. The tumor was a hard round body, a little larger than a hazel-nut, attached to the superior maxillary bone, far back in the orbit, close to the sphenomaxillary fissure. It was removed with chisel and elevator. A horse-hair drain was introduced into the wound, which was closed with sutures. Patient did well after the operation, and left the hospital at the end of a fortnight, at which time the wound was healed, except along a narrow fistulous track leading to its deepest part. The exophthalmos had almost entirely disappeared. The tumor

consisted of a shell of compact bony tissue, containing a large nucleus of cartilage (?).

[I have had an opportunity of examining the specimen of the tumor in the museum of the New York Hospital, and it is made up of cancellous tissue (not cartilage) with a thin shell of compact tissue covering one side of it.—
AUTHOR.]

It was formerly customary to designate every bony formation in the orbit which showed itself above the plane of the bone an *exostosis*. Cruveilhier was the first observer to direct attention to the differences between the bony tumors of the orbit. He showed that these growths developed in the interior of the bone in such a manner as to push the peripheric layer of bone before them like a capsule; he therefore called them "*incapsuled* bony growths" (*corps osseux enkystés*) ("*Anatomie Pathologique*," J. Cruveilhier, tome iii., p. 871). Subsequently Virchow studied the nature of these tumors, and he showed that the orbital osteomata in general may develop in various ways; a great number of them, he believed, originated in the diploë, and in their further development distended the shell of bone enclosing them, which they gradually broke through. These tumors Virchow called *enostoses*, thus separating this form of osteoma from the class of exostoses.

The situation of these growths in the frontal and ethmoidal sinuses, etc., is readily determined, but the question of the actual starting-point is not so easily answered. Rokitansky has suggested that these osteomata of pneumatic cavities were developed from *enchondromata*; but we shall see by reference to the cases of this disease which I have here collected (representing all the cases which have been carefully recorded in literature), that there is no foundation for this opinion.

Professor Arnold, of Heidelberg (*Virchow's Archiv*, 1873, vol. lvii., p. 159), has suggested that the tumors in question were developed from remnants of foetal cartilage, giving as the only support for this opinion the man-

ner of development of enchondromata from remains of cartilage in other parts of the body. He assumes that at least a part of the osteomata were originally enchondromata, and adduces the fact that a superficial layer of cartilage has been found covering some of these tumors (Case of John Windsor, *Annales d'Oculistique*, 1884, t. xii., p. 211). Then there is the type of development which refers the origin of these tumors to the *endosteum* (?) by direct production of bone-tissue.

By referring to the cases of *osteoma of the frontal sinuses* which I have collected, it will be seen that in those cases in which a careful history has been preserved, and there are data of the time when the growth was first noticed, the latter was noted to have occurred about the period of puberty; therefore, just about the time when these cavities, which are absent at birth, develop with the greatest energy. But the cases of Demarquay and Solger and others show that osteomata may, in exceptional cases, form in fully developed frontal sinuses.

In consequence of abnormal development in the segment of the frontal bone bordering on the ethmoid, Arnold states, remnants of cartilage may be the starting-point of the new formation, which is first seen as an enchondroma, and later is changed into an osteoma by total ossification (*Virchow's Archiv*, vol. lvii., p. 161).

Pathological anatomy.—Osteomata of the *frontal sinuses* are, as a rule, hard like ivory and irregular in form, with a partly nodular or mammillated surface, sending out conical processes, with which they fasten themselves in the different cavities into which they grow; a fact of great importance to remember in connection with the operation for their removal. Shallow furrows and holes are frequently found in the surface for the reception of blood-vessels and invaginations of the periosteum; or, as noted in two of the cases which we have cited, the grooves in the surface have resulted from the tumor having, while growing, met with resistance from normal osseous projections, ledges, tendons, etc.

The external form of osteomata of the frontal sinuses seems to be essentially influenced by the resisting bodies against which they impinge in growing; and as these are pretty much the same in all cases, it is not curious that these tumors should bear a striking resemblance to one another. We generally find the *largest portion* of the growth in the *frontal sinus*, and a small projection from it in the orbit

On close inspection, it will be seen that the osteomata of the frontal sinuses consist of two different substances—a thick, ivory-like shell, which generally preponderates,

and a spongy portion; the consistence of the former exceeding, in point of hardness, normal compact bone. The spongy portion consists of a system of delicate bony plates, with soft, vascularized tissue between them. When the tumor is cut open, its cut surface displays concentric and radial lines in the ivory substance. The tumor adheres to the frontal bone either by a small pedicle or a broad base of spongy bone.



FIG. 11.—Dolbeau's Case of Osteoma of Frontal Sinus.

Dolbeau maintained, on the basis of pathologico-anatomical investigations and on observations, that the osteomata (exostoses) of the frontal sinus always sprang from the mucous membrane and never from the osseous substance of the wall

of the frontal sinus, and that, consequently, by a free opening of the frontal sinus they might be extirpated, just as a stone is removed from the bladder in lithotomy (see Fig. 11). This statement is certainly *incorrect*, as is shown by my own case, and those of others which have been accurately described.

The published cases of osteomata of the frontal sinuses show that the consistence of these growths differs according to preponderance of the spongy or the ivory substance. Generally the ivory-like shell preponderates, and there may be only a trace of spongy bone; then, again, in rare cases, the tumor may consist chiefly of a spongy mass, on which ivory bone plates are scattered, making the entire growth softer than normal bone. In the majority of the cases which were carefully observed, the entire surface was covered with a delicate connective-tissue envelope; in some instances, parts of this envelope were the seat of polypous excrescences, which sprang out of remains of mucous membrane which had atrophied under the pressure to which it had been subjected by the tumor.

All osteomata of the frontal sinuses not alone distend, but perforate, the walls of the sinuses; but they do not show a tendency to coalesce with the walls of bone which they pierce—a fact of great practical importance in connection with the operation for their removal.

The *perforations* take place, most frequently, *outward* through the anterior plate of the frontal bone, and through the roof of the orbit into the orbital cavity. They rarely project into the nasal cavity. The os planum of the ethmoid bone and the lachrymal bone are destroyed in exceptional cases, where the tumor has such a broad base projecting into the ethmoidal cells that the point of origin of the tumor cannot be made out. Perforation through the inner plate of the frontal bone into the cranial cavity is not uncommon, and this may take place, as is shown by Arnold's case, at an early period, when the tumor was not quite as large as a walnut. The cases recorded show

that osteomata of the frontal sinuses may be *unilateral* or *bilateral*; but, in the latter case, there may be only one tumor, perforation taking place through the septum, which seems to be the more common. Then there may be several partly pediculated osteomata in one sinus. But that all osteomata do not, as Arnold asserts, originate in the posterior wall of the frontal sinus, is shown by the cases of Banga, Jobert, and Demarquay, in which the growth was implanted into the anterior plate of the frontal bone.

The osteomata of the ethmoidal cells are, as a rule, spherical in shape, with an irregular nodular surface of the same anatomical structure as the osteomata of the frontal sinuses.

Antrum of Highmore and ethmoidal.—The histological relations in the maxillary cavity are analogous to those in the frontal sinuses, and all the hypotheses relating to the development of these tumors can be applied to tumors of the antrum of Highmore. Arnold's embryological investigations might here likewise come into consideration, since also in this locality preformed cartilaginous parts of the primordial skeleton are found.

The osteomata of antrum Highmori develop in the interior of the antrum of the superior maxilla, from one of the walls of this cavity, and they are generally ~~uncapsu~~incapsuled. These tumors also show a tendency to become spontaneously detached by suppuration, a peculiarity which seems to be common to incapsuled osteomata. From the few carefully observed cases of osteomata of the antrum Highmori, it appears that they spring from the medial wall, and show a tendency to grow laterally. They are covered with mucous membrane.

The osteomata of the sphenoidal sinus, as a rule, first extend into the cranial cavity.

All orbital osteomata, external or incapsuled, always show the same structure; *i.e.*, they are composed of an ivory-like portion and a spongy portion; and it seems probable that they all spring directly from the perios-

teum, and as they grow, the spongy portion is formed by resorption of the ivory mass.

Symptoms.—All orbital osteomata grow very slowly, and, when uncomplicated, are generally painless and without inflammatory symptoms.

Frontal sinus.—In osteoma of the frontal sinus, the patient's attention is first attracted to his disease by the presence of a tumor at the *upper inner angle* of the orbit. When the disease is *bilateral*, the prominence takes place in the *middle of the forehead*, directly above the *root of the nose*. Sometimes a collection of pus and mucus in the frontal sinuses complicates these tumors. But the formation of polypi and suppuration in the frontal sinuses, which sometimes complicate these tumors, does not, as has been supposed, give rise to the development of the osteoma; but these conditions are, on the contrary, the result of the presence of the tumor, which, by closing the channel leading to the nasal cavity, gives rise to retention of mucus in the frontal sinuses, and also the mechanical irritation to which the mucous membrane is subjected during the growth of the tumor. An acute suppurative process may be set up in the cavity, and perforation take place through the walls of the sinus; the external plate of frontal bone being, by preference, the seat of perforation, the pus then making its way, generally, at the inner angle of the orbit, or, as has been observed in an exceptional case, at the upper outer angle, and leading in either case to a fistula in the bone. The *eye is displaced forward and downward and a little outward*. On account of the slow growth of these tumors the *vision* may long remain unimpaired. Conjunctivitis, ciliary neurosis, disturbance of circulation and inflammatory changes in the retina, and ulceration of the cornea, may result from mechanical disturbance of the eyeball; but they grow so slowly that the eye tolerates their presence for a long time, without having its vision materially disturbed thereby. The *inner plate* of the *frontal bone* may be perforated by the tumor, and the latter

attain to considerable dimensions without giving rise to any brain-symptoms. Osteomata of the frontal sinus have, after projecting into the ethmoidal cells, extended to the lamina cribrosa, and through it into the cranial cavity, in which case the osteoma appears to arise from the ethmoidal sinus. But it is more common for tumors in this region to perforate the inner wall of the sinus and invade the cranial cavity.

Ethmoidal sinuses.—The osteomata of the ethmoidal are, as a rule, first observed as a hard tumor at the *inner angle of the orbit*, increasing in its growth from within outward, whereby the eyeball is displaced laterally; the upper margin of the orbit is also sometimes forced upward, and the lower margin downward. But this takes place only in those cases in which the orbital portion of the growth has been very large.

Osteomata of the ethmoidal sinuses may intrude into the nasal cavity. Vision may be normal or greatly impaired. Choked disk has been observed in such cases, and ulceration of the cornea may result where the exophthalmos is so pronounced as to interfere with the closing of the eyelids.

External exostoses.—In the ten cases of *external exostosis* cited above, traumatism was the assignable cause of the exostosis in two cases only. The youngest patient was eighteen years of age and the oldest fifty-one years of age. These exostoses spring from the periosteum. They are generally of the same anatomical structure as those of the frontal and ethmoidal sinuses, consisting of an ivory-like shell with a nucleus of spongy bone. These external exostoses grow much more slowly than the osteomata of the frontal and ethmoidal sinuses, nor do they attain to the same enormous dimensions as do the latter.

The external exostoses of the orbit are generally found at the *upper border of the orbit*, although they may occur at any portion of the orbital border, so that it is not always possible to distinguish between these exostoses

and those springing from the frontal and ethmoidal sinuses before the operation.

Antrum of Highmore.—The osteomata in this region spring, as we have seen, from the medial wall of the cavity and show a tendency to grow laterally. The tumor therefore first shows itself, as a rule, behind the lower eyelid, and the eyeball is displaced first upward, then forward and outward. The osteomata in this region break through the thin floor of the orbit, and project into the nasal cavity sooner than the osteomata of the frontal or ethmoidal sinuses; so that the nasal passages are disturbed early in the disease. Perforation into the cranial cavity is rare; I find it mentioned only once, in a case in which the tumor had grown to an enormous size. They are rarely bilateral.

Sphenoidal sinuses.—Osteomata in this region affect the sight, by compression of the optic nerve in the canalis opticus, earlier than the osteomata of the other cavities alluded to. This is readily anticipated on account of the proximity of the growths to the optic nerve. Osseous growths in this region show a disposition to intrude into the cranial cavity at an early stage of the disease.

It has been held that the persistent dropping of fluid (cerebro-spinal fluid) from the nostril, associated with atrophy of the optic nerves and other brain-symptoms observed by Priestley Smith, Baxter, Nettleship, Leber, and others, had an intimate connection with polypoid excrescences and the associated inflammatory affection of the ethmoidal and sphenoidal sinuses. Leber, as is well known, refers these symptoms to hydrocephalus internus, which, in complete ossification of the skull, would give rise to symptoms of brain-pressure.

This circumstance is incidentally referred to here because, since the anatomical investigations of Axel Key and Retzius, the presence of one of these symptoms—dropping of cerebro-spinal fluid—in osteoma of the ethmoidal and sphenoidal, or even frontal, sinuses would have a practical and important bearing on the prognosis of the

case. Axel Key and Retzius found that the nervi olfactorii are surrounded by lymph-sheaths which communicate with the subdural spaces, and empty freely on the surface of the mucous membrane of the nose—that the subdural and subarachnoidal fluid of the brain may run off by the lymph-channels of the nose. Therefore, the escape of cerebro-spinal fluid (as demonstrated by chemical analysis by Robin and Mehu), in the case recorded by Tillaux, after evulsion of nasal polypi, would be accounted for by assuming an injury to the lamina cribrosa, but which, like those cases of trauma (in which this symptom was present) recorded by Sir James Paget and Bidloo, was not associated with disease of the optic nerve and those symptoms of cerebral pressure, anosmia, motor weakness, and convulsions which Leber has explained to be due to hydrocephalus internus, giving rise, by pressure, to a small dehiscence in the wall of the ethmoidal or sphenoidal sinuses, and thus to the escape of cerebro-spinal fluid. So long as the tumor is within the limits of the sphenoidal sinus, there may be no subjective symptoms. As the growth increases in size, it enlarges the sinus, and occasions atrophy of its walls, and compresses the optic nerve and the neighboring parts. One or both optic nerves may be affected, and amaurosis result. When the tumor breaks through the walls of the sphenoidal sinus, it extends into the nasal fossa, ethmoidal sinus, and into the orbit, or cranial cavity; and the latter may take place without giving rise to any subjective symptoms. In a later stage, epileptiform seizures may take place. Death generally results from meningitis or brain-abscess.

Diagnosis.—The condition with which osteoma of the frontal and ethmoidal sinuses is most likely to be confounded is a sarcoma with bony spicula or a collection of fluid in these cavities, in consequence of which the sinuses become distended and give rise to a prominence at the place in the orbit at which osteomata of the sinuses in question first show themselves. These retention-

tumors are not stone hard like the incapsuled osteomata, but yield to pressure. It is, however, not always possible to make the distinction before exposing the growth by an operation. The drill is of value in making the differential diagnosis in such cases. But when we have these inflammatory conditions as complications of the osteoma, it is not possible to make a distinction. It is, however, of great practical importance to distinguish between the exostoses originating within the orbit and the osteomata of the frontal and ethmoidal sinuses. The exostoses of the orbit, as we have said, may occur at any part of the orbital border, but they have been observed most frequently at the upper margin of the orbit, and they grow much more slowly than the osteomata in either the frontal or ethmoidal cavities. But, after all, a positive diagnosis is only generally made at the operation.

Multiple hyperostoses and diffuse bony prominences occur in the orbit, which are distributed over a considerable extent of the bone, in connection with some of which constitutional syphilis plays a significant part.

Prognosis.—Spontaneous exfoliation of osteomata of the *ethmoidal sinuses* has been observed in several cases, but the resultant deformity has been frightful. This spontaneous exfoliation has been the result of trauma in most of the cases recorded. Spontaneous exfoliation of osteomata of the frontal sinuses has also been observed in four cases; but this is rare, and the danger to life is far greater in osteomata of the frontal sinuses than in those of the ethmoidal sinuses, on account of the proximity of the latter to the brain and their tendency to perforate the walls of the sinus and extend into the cranial cavity. We can only hope to successfully remove these osteomata by surgical operation. Berger and Tyrmann show that of nine cases collected by them of osteomata of the frontal sinus, which projected into the ethmoidal cells, and in which an operation for their removal was performed, six ($66\frac{2}{3}$ per cent.) died from meningitis. When an osteoma of the frontal sinus has

invaded the ethmoidal sinuses, it has, probably, also perforated the cranial cavity. The operations which I have seen performed on the cranium by general surgeons have convinced me that the prognosis need not be so unfavorable in the latter class of cases, when the operation is performed with care and under antiseptic precautions.

Sphenoidal sinus.—Osteomata in this region generally first extend into the cranial cavity. No case of successful removal of an osteoma from this sinus has been recorded.

Antrum Highmori.—The prognosis after removal of osteomata from this cavity is good, the operative removal of osteomata from this cavity having been favorable in nearly all of the cases recorded.

Berlin states that thirty-eight per cent. of the cases collected by him of osteoma of the orbit which had been operated upon were fatal. This statement applied to osteomata of the orbit in general ; but I believe that we should distinguish in such statistics between the regions involved by the osteoma. For instance, Bornhaupt collected 11 operated cases of osteomata of frontal sinus, of which number 7 died of meningitis (sixty-three per cent.), 2 recovered, and of 2 cases the result was unknown.

But the majority of the cases from which these statistics were collected were examples of osteomata which had grown to large dimensions, and had already produced great destruction of the walls of the cavities into which they intruded—in some instances projecting into the cranial cavity—and, as in Tweedy's case, giving rise to degenerative changes in the brain itself. It is unfair to make such cases represent the actual danger of orbital osteomata.

Treatment.—You will observe, by referring to the cases which I have collected, that in osteomata of the frontal and ethmoidal sinuses, etc., we have to deal with a disease which offers the best chances for successful removal when the operation is undertaken at an early period of its existence, before a diseased condition of the tissues (es-

pecially suppurative) surrounding the growth has set in ; and the latter condition must always constitute an element of great danger in connection with the operation.

There is another reason for operating just so soon as a diagnosis can be made, especially in the case of osteoma of the frontal sinus ; *i.e.*, no matter how small the orbital portion of the tumor may be, it is impossible by the orbital portion alone to judge of the real size and extent of an exostosis springing from the frontal sinus. This fact is strikingly shown by Tweedy's case ("Oph. Hosp. Reports," 1882, vol. x., p. 303). The orbital portion of the tumor may be the size of a pea, and yet the entire sinus be filled with the body of the growth.

In our efforts to remove an osteoma from the frontal sinus, it is, I believe, *always better to break down the wall of the cavity through which it has made its passage into the orbit than to make an attempt to remove the growth from the cavity by attacking the body of the growth itself*, since the latter is so hard that a chisel can be forced into it only by employing an unnecessary and harmful amount of violence. It is always reprehensible practice to attempt the removal of an osteoma by attacking it at its apex. The mallet and chisel are, I believe, the best instruments to employ in the removal of these growths.

In every instance the operation should be performed under antiseptic precautions, and after the removal of the osteoma the sinus should be thoroughly searched for polypi which may spring from the lining membrane of the cavity, and when found they should be carefully removed, and the cavity washed with an antiseptic fluid and the wound covered with an antiseptic dressing.